CLAIM

1. A sound acquisition method for acquiring sound from each sound source by microphones of plural channels according to the present invention, comprising:

(a) a state deciding step including an utterance deciding step of deciding an utterance period from signals received by said plural-channel microphones;

(b) a sound source position detecting step of detecting the position of said each sound source from said received signals when the utterance period is decided in said utterance deciding step;

(c) a frequency domain converting step of converting said received signals to frequency domain signals;

(d) a covariance matrix calculating step of calculating a covariance matrix of said frequency domain received signals;

(e) a covariance matrix storage step of storing said covariance matrix for each sound source based on the result of detection in said sound position detecting step;

(f) a filter coefficient calculating step of calculating filter coefficients of said plural channels based on said stored covariance matrix and a predetermined output level;

(g) a filtering step of filtering the received signals of said plural channels by filter coefficients of said plural channels, respectively; and

(h) an adding step of adding together the results of filtering in said plural channels, and providing the added output as a send signal.

2. The sound acquisition method according to claim 1, which further comprises an acquired sound level estimating step of estimating the acquired

sound level for utterance from said each sound source based on a covariance matrix stored corresponding to said each sound source, and wherein said filter coefficient calculating step includes a step of calculating said filter coefficients of said plural channels based on said covariance matrix stored corresponding to said each sound source and said estimated acquired sound level so that the output level becomes a desired level.

3. The sound acquisition method according to claim 2, wherein: said state decision step includes a noise decision step of deciding a noise period from said acquired signals of said plural channels;

said covariance matrix calculating step includes a step of calculating, when said noise period is decided, a covariance matrix of acquired signal during said noise period as a covariance matrix of noise;

said covariance matrix storage step is so adapted as to store said covariance matrix of said acquired signal in correspondence to each sound source and store said covariance matrix of said noise period; and

said filter coefficient calculating step is so adapted as to calculate filter coefficients of said plural channels, based on a covariance matrix stored corresponding to said each sound source in said utterance period and a stored covariance matrix in said noise period, so that the acquired sound level for said each sound source becomes a desired level and that noise is reduced.

4. The sound acquisition method according to claim 2, in which a loudspeaker for reproducing a received signal is disposed in said acoustic space, wherein: said state decision step includes a receive decision step of deciding a receiving period from said received signal;

said frequency domain converting step includes a step of converting said received signal to a frequency domain signal;

said covariance matrix calculating step calculates said covariance

matrices in said utterance period and said receiving period from said frequency domain acquired signals of said plural channels and said frequency domain received signal;

said covariance matrix storage step stores said covariance matrix corresponding to each sound source in said utterance period and said covariance matrix in said receiving period; and

said filter coefficient calculating step calculates said filter coefficients of said plural channels, based on a covariance matrix stored corresponding to said each sound source in said utterance period and a stored covariance matrix in said noise period, so that the acquired sound level for said each sound source becomes a desired level and that noise is reduced.

5. The sound acquisition method according to any one of claims 1 to 4, wherein: the number of said sound sources is K equal to or greater than 2; and said filter coefficient calculating step calculates said filter coefficients after assigning weights C_{S1} to C_{SK} of sensitivity constraints for said K sound sources to covariance matrices corresponding to said K sound sources, said weights assigned to said sound source being reduced in order of utterance of said sound sources.

6. The sound acquisition method according to any one of claims 1 to 4, wherein, assuming that said plural channels are M channels, said filter coefficient calculating step calculates said filter coefficients after whitening each covariance matrix $\mathbf{R}_{XX}(\omega)$ by multiplying said each covariance matrix by a weight $1/\{\mathbf{D}^{H}\mathrm{diag}(\mathbf{R}_{XX}(\omega))\mathbf{D}\}$ based on a diagonal component $\mathrm{diag}(\mathbf{R}_{XX}(\omega))$ and a matrix $\mathbf{D}$ of arbitrary M or M+1 rows.

7. The sound acquisition method according to any one of claims 1 to 4, wherein said covariance matrix storage step averages a previously stored covariance matrix and a covariance matrix newly calculated by said

covariance matrix calculating step and stores the averaged covariance matrix as the current covariance matrix.

8. A sound acquisition apparatus which acquires sound from each sound source by microphones of plural channels placed in an acoustic space, comprising:

a state decision part including an utterance deciding part for deciding an utterance period from signals received by said plural-channel microphones;

a sound source position detecting part for detecting the position of said each sound source from said received signals when the utterance period is decided by said utterance deciding part;

a frequency domain converting part for converting said received signals to frequency domain signals;

a covariance matrix calculating part for calculating a covariance matrix of said frequency domain received signals of said plural channels;

a covariance matrix storage part for storing said covariance matrix for said each sound source based on the result of detection by said sound position detecting part;

a filter coefficient calculating part for calculating filter coefficients of said plural channels by use of said stored covariance matrix so that the send signal level for said each sound source becomes a desired level;

filters of said plural channels for filtering the received signals from said microphones by use of the filter coefficients of said plural channels, respectively; and

an adder for adding together the outputs from said filters of said plural channels and for providing the added output as a send signal.

9. The sound acquisition apparatus according to claim 8, which further includes

an acquired sound level estimating part for estimating the acquired sound level for said each sound source from said covariance matrix stored corresponding to said each sound source, and wherein said filter coefficient calculating part is so adapted as to calculate said filter coefficients of said plural channels after assigning a weight to the covariance matrix corresponding to said each sound source based on said estimated acquire sound level so that the send signal level for said each sound source becomes a desired level.

10. A sound acquisition program for executing said sound acquisition method of any one of claims 1 to 7 by a computer.

11. A sound acquisition method for acquiring speech sound from at least one sound source by a microphone of at least one channel in an acoustic space in which a received signal is reproduced by a loudspeaker, comprises:

(a) a state deciding step of deciding an utterance period and a receiving period from the sound acquired by said microphone of said at lest one channel and said received signal;

(b) a frequency domain converting step of converting said acquired signal and said received signal to frequency domain signals;

(c) a covariance matrix calculating step of calculating a covariance matrix in said utterance period and a covariance in said receiving period from said frequency domain acquired signal and received signal;

(d) a covariance matrix storage step of storing said covariance matrices for said utterance period and for said receiving period, respectively;

(e) a filter coefficient calculating step of calculating filter coefficients of the same number as that of channels for said acquired signal and a filter coefficient for said received signal based on said stored covariance matrices in said utterance period and said receiving period so that an acoustic echo is

cancelled which is a received signal component contained in said received signal;

(f) a filtering step of filtering said received signal and said acquired signal by use of said filter coefficients for said received signal and filter coefficients for said acquired signal of said at least one channel; and

(g) an adding step of adding together said filtered signals and providing the added output as a send signal.

12. The sound acquisition method according to claim 11, wherein: said state decision step includes a step of deciding a noise period from said acquired signal and said received signal; said covariance matrix calculating step includes a step of calculating a covariance matrix in said noise period; said covariance matrix storing step includes a step of storing said covariance matrix in said noise period; and said filter coefficient calculating step calculates received signal filter coefficients of said at least one channel and said acquired signal filter coefficients based on said stored covariance matrices in said utterance period, said receiving period and said noise period so that said acoustic echo and noise are cancelled.

13. The sound acquisition method according to claim 11, in which said microphone is provided in each of plural channels for acquiring speech sound from a plurality of sound sources, and which further comprises a sound source position detecting step of detecting the sound source position from acquired signal from said plurality of microphones when said utterance period is decided by said state decision step; and wherein said covariance matrix storage step stores said covariance matrices in correspondence to said detected sound source position and said receiving period based on the result of decision by said state decision step and said detected sound source position.

14. The sound acquisition method according to claim 13, wherein said filter coefficient calculating step calculates said filter coefficients after assigning weights C_{S1} to C_{SK} of sensitivity constraints for K sound source positions to covariance matrices corresponding to respective sound sources, said weights assigned to said sound source positions being reduced in order of utterance of said sound sources.

15. The sound acquisition method according to any one of claims 11 to 14, wherein said plural channels are M channels equal to or greater than 2, and said filter coefficient calculating step calculates said filter coefficients after whitening each covariance matrix $\mathbf{R}_{XX}(\omega)$ by multiplying said each covariance matrix by a weight $1/\{\mathbf{D}^H \mathrm{diag}(\mathbf{R}_{XX}(\omega))\mathbf{D}\}$ based on a diagonal component $\mathrm{diag}(\mathbf{R}_{XX}(\omega))$ and a matrix $\mathbf{D}$ of arbitrary M or M+1 rows.

16. The sound acquisition method according to any one of claims 11 to 14, wherein said covariance matrix storage step averages a previously stored covariance matrix and a covariance matrix newly calculated by said covariance matrix calculating step and stores the averaged covariance matrix as the current covariance matrix.

17. A sound acquisition apparatus according to the second aspect of the present invention comprises:

a microphone of at least one channel for acquiring speech sound from a sound source and for outputting an acquired signal;

a loudspeaker for reproducing a received signal;

a state decision part for deciding an utterance period and a receiving period from said acquired signal and said received signal;

a frequency domain converting part for converting said acquired signal and said received signal to frequency domain signals;

a covariance matrix calculating part for calculating covariance

matrices of said acquired and received signals of said frequency domain for said utterance period and for said receiving period, respectively;

a covariance matrix storage part for storing said covariance matrices for said utterance period and for said receiving period, respectively;

a filter coefficient calculating part for calculating filter coefficients for said acquired signal of said at least one channel and filter coefficients for said received signal based on said stored covariance matrices so that an acoustic echo of said received signal is cancelled;

an acquired signal filter and a received signal filter having set therein said filter coefficients for said acquired signal and said filter coefficients for said received signal, for filtering said acquired signal and for filtering said received signal; and

an adder for adding together the outputs from said acquired signal filter and said received signal filter, and for providing the added output as a send signal.

18. The sound acquisition apparatus according to claim 17, wherein said microphone and said acquired signal filter are both provided in each of plural channels, and said adder adds together outputs from said acquired signal filters of said plural channels and the output from said received signal filter and provides the added output as a send signal.

19. The sound acquisition apparatus according to claim 18, wherein: said state decision part includes a noise decision part for deciding a noise period from said acquired signal and said received signal; said covariance matrix calculating part is so adapted as to calculate covariance matrices of said acquires signal and said received signal in said noise period; said covariance matrix storage part is so adapted as to store said covariance matrices in said noise period; and said filter coefficient calculating part is so

adapted as to calculate filter coefficients of said plural channels based on said stored covariance matrices so that an acoustic echo and noise of said received signal are cancelled, and as to set the calculated filter coefficients in said filters of said plural channels.

20. The sound acquisition apparatus according to claim 19, which further comprises a sound source position detecting part for detecting positions of K sound sources based on acquired signals of said plural channels; and wherein said covariance matrix calculating part is so adapted as to calculate a covariance matrix in said utterance period for each sound source; said covariance matrix storage part is so adapted as to store said covariance matrix in said utterance period in correspondence to each sound source; and said filter coefficient calculating part includes means for calculating said filter coefficients after assigning weights C_{S1} to C_{SK} of sensitivity constraints for the respective sound sources to covariance matrices corresponding to said respective sound sources, said weights assigned to said sound sources being reduced in order of utterance of said sound sources.

21. A sound acquisition program for executing said sound acquisition method of any one of claims 11 to 16 by a computer.